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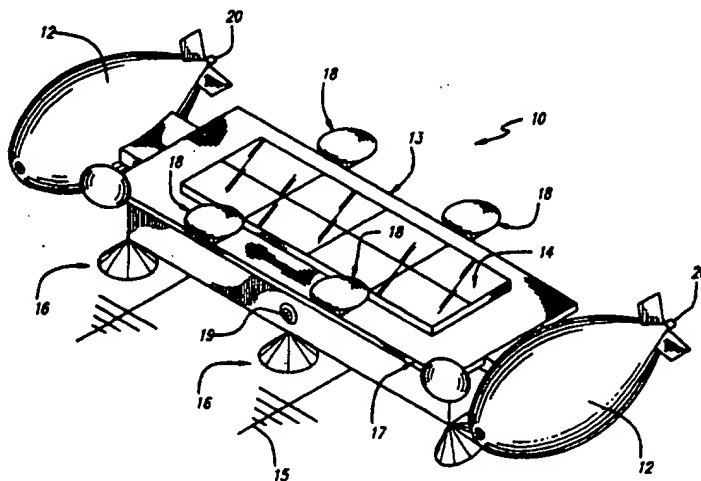
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## (57) Abstract

The present invention is a concept of achieving global telecommunication, using stationary platforms (10) up to stratospheric heights. These platforms (10) are environmentally compatible, can be built at one-tenth the cost of a satellite and are reusable. The present invention also concerns the Corona Ion Engine (20) for moving assemblies in the stratosphere, where atmospheric pressure is low, resulting in low drag and turbulence. This engine (20) includes an electrode and means for biasing the electrode to maintain the electrode at a selected electric potential with respect to another electrode and for producing a plasma which comprises negative and positive ions. Direct solar energy heating (14) using optical lenses is also possible. Enhancement of emission of electrons at the electrode and subsequent ionization by solar ultraviolet radiation is included.

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**HIGH-ALTITUDE LIGHTER-THAN-AIR STATIONARY PLATFORMS INCLUDING ION ENGINES****REFERENCE TO RELATED APPLICATIONS**

- 10 This is a continuation-in-part of application U.S. Pat. Ser. No. 527,284, filed May 5, 1994, which is a continuation of U.S. Pat. Ser. No. 238,473, filed May 6, 1994, now abandoned.

**BACKGROUND OF THE INVENTION**

15 1. Field of the Invention

This invention relates to the field of communications and more specifically to a telecommunications platform that is capable of being precisely positioned within the troposphere or stratosphere for providing regional and global communications that is economically and environmentally compatible.

20

2. Background of the Invention

25 The present invention, a system of high altitude lighter-than-air telecommunication platforms, is specifically designed to provide an economical and environmentally compatible system for effecting global and regional telecommunication. A Corona Ion Engine™, using ambient air as fuel and solar radiation as power source, permits each communication platform to be stationary and long-lasting at stratospheric heights. The high altitude reduces wind-drag and allows a large foot-print to be covered. Laser communication between platforms is

5 possible because scattering is minimized as a result of the low atmospheric density. This global communication system will complement the present global satellite communication network.

### OBJECTIVES OF THE INVENTION

10 Technological advances in the field of communications and more particularly in the field of satellite-based communications systems have allowed for great advancements in regional and global communications. Today, satellites serve as the main vehicles for achieving global telecommunication. Typically, they are launched into orbit by rockets or by Space Shuttle and then either circle the globe or remain geo-stationary. Recent research has  
15 revealed that exhausts from rockets have a damaging effect on the environment, such as on the ozone layer. In addition, the short lifetime (three to five years) of orbiting satellites and rockets means they will plunge into the atmosphere, generating space debris as layers of metallic dust, which poses serious environmental problems.

The multi-billion dollar Iridium Project is a state-of-the-art example of this  
20 technology. At its completion at the end of the Twentieth Century, seventy-seven satellites will encircle the globe with telecommunication services. Each of these satellites will have to be replaced periodically, because of fuel depletion or equipment failure.

Geosynchronous satellites must orbit far above the earth's equator (6.6 earth radii away). The allowable number of satellites in synchronous orbits is limited and their great  
25 distance from earth precludes direct control by small transmitters like cellular phones.

As the global demand for communication services increases, satellite development, launching and maintenance will expend more and more resources. Economic and

5 environmental concerns, coupled with expensive cleanup of satellite debris, could severely restrict future satellite launchings. When this comes to pass, it will no longer be feasible exclusively to support a satellite-based, global telecommunication network. A need therefore exists in the art for a less expensive and more environmentally compatible alternative method for creating regional and global communications networks.

10 The stationary platform described in this patent serves as an alternate communication network which can complement and supplement the existing satellite system. This alternate telecommunication technology is cost-effective, environmentally sound and operates in the stratosphere, 12-30 kilometers above the earth. This platform bears the trademark name of Sky Station™. Sky Station™ represents an enormous economic advantage over satellite-  
15 based communication services. It is estimated that leasing time on Sky Station™ will be one percent the cost of current satellites because of the following major cost-saving features.

Sky Station™ does not require launching by expensive rockets or Space Shuttle. It ascends to its operating station via its buoyancy and under its own power from a conventional solar-powered engine and the Corona Ion Engines™.

20 Sky Station™ can lift tons of payload, whereas most satellites can only manage hundreds of pounds. Thus Sky Stations™ can carry enough equipment for broadcasting over a wide range of bandwidths and frequencies. This allows them to support the entire spectrum of radio, television, cellular phone, microwave infrared and optical communications from a single location for one or several states. This concept of a high-altitude relay station has  
25 already proved to be successful and economically viable in many large cities.

Sky Stations™ can carry equipment for astronomical observations in the wavelength range from ultraviolet to infrared because of their lifting capacity and because they operate

5 above 99 per cent of the atmosphere. These platforms are kept at precise locations, using the  
Global Positioning Satellites (GPS) navigation system or alternately, ground-based,  
triangulation stations.

Sky Stations™ require less transceiver power because they are so much closer to the  
earth than geo-stationary satellites. Thus smaller batteries and antennas can be used and  
10 communication with conventional cellular phones can be direct rather than indirect, as  
through a satellite dish. This capability means an entire region of a country could be one  
"cell," thus eliminating the complex and costly multi-cellular phone grid that presently  
blankets our urban centers. These unsightly cells are often unwelcomed by neighborhoods.  
Every transmission in the area would go directly from the sender up to Sky Station™ and  
15 directly back down to the receiver.

Sky Stations™ are more sustainable than satellites. Their modular design, fabricated  
from modern composite materials, enables them to remain aloft for a minimum of five years  
before requiring service. In the unlikely event they require intermediate servicing, they can  
be brought down by special aircraft to a lower altitude for servicing. If this happens, another  
20 Sky Station™ will be dispatched in advance so that communication will not be disrupted.  
Satellites can only be serviced by expensive and difficult-to-schedule Space Shuttle missions.

Sky Stations™ are recyclable. If necessary, Sky Stations™ can be completely  
refurbished by returning them to the launch site and landing them. Satellites are not  
recyclable. Their orbits decay, plunging them back into the atmosphere where they burn up.  
25 We can foresee a day when we will no longer be able to afford, either economically or  
environmentally, a disposable global communication system.

Sky Stations™ are more flexible than orbiting satellites because these satellites

5 remain over a city only for a few minutes during each pass and therefore have to keep relaying data to the next satellite. By contrast, because it is stationary and large enough to maintain the necessary equipment, Sky Station™ always has the flexibility to retransmit immediately, store and forward, or transmit to another Sky Station™.

The advance airship technology required to build The Sky Station™ platforms exists  
10 today. One Sky Station™, approximately 200 meters long, with a total volume of 400,000 cubic meters, will be capable of lifting a two-ton payload. That would provide ample coverage for average-size cities and rural areas. Coverage depends on three major factors, the altitude at which the Sky Station™ operates, the volume of transmissions it has to handle and the terrain over which it operates. Therefore, the very largest and most densely populated  
15 cites, such as Tokyo or Los Angeles, may require additional Sky Stations™ because of the extremely high volume of transmissions. Multiple Sky Stations™ would be inter-linked by lasers to provide continuous coverage. This concept can be applied to cover vast regions like Europe, Southeast Asia or the entire globe.

Urban dwellers will benefit from Sky Station™ because they will have disaster-  
20 resistant, nearly unlimited communication capabilities, without a profusion of expensive and unsightly towers. In January, 1995, many lives were lost in Kobe, Japan, because the earthquake knocked out virtually all communications. Sky Station™ is not subject to earthquakes or the weather. It can also facilitate numerous specialized applications, such as medical and traffic monitoring.

25 People living in remote or underdeveloped areas will benefit from the "leapfrog" in communication technology without having to go through the costly and time-consuming progression from wires to fiber optics to satellites. With the launch of a single Sky Station™,

5 everyone in vast areas of Eastern Europe or Africa would immediately gain "state-of-the-art" communication systems.

One Sky Station™ can cover the entire country of Italy. Using a footprint of 1000 kilometers, one Sky Station™ would cover most of Italy, including major metropolitan areas. Two stations might be employed for better coverage of the mountainous northern region,  
10 duplicate coverage of Rome and the populous central region and coverage of the Adriatic Sea and part of the Mediterranean Sea areas.

Therefore, it is an object of the present invention to provide an economical and environmentally compatible telecommunication system for regional and global communication.

15 It is yet another objective of the invention to provide for a system high altitude telecommunications platforms that can be launched from the ground via flotation using lighter-than-airships. This launch capability represents a considerable savings over Space Shuttle launches.

It is yet another objective of the invention to provide for a telecommunication system  
20 consisting of a series of reusable platforms that can be returned to earth for repair or updating and then returned to operation. Whereas conventional satellites have a finite life and must be retrieved by a Space Shuttle launch or they will fall back to earth, being destroyed in the process.

It is another objective of the invention to provide for a series of high altitude  
25 platforms that are capable of carrying large telecommunication payloads and which are capable of remaining on position above a given region on the earth for prolonged periods of time.



5           Finally, it is an objective of the invention to provide for a series of telecommunication platforms, each of which is propelled and maintained in a geo-stationary orbit above a given region of the earth by use of a Corona Ion Engine. A Corona Ion Engine utilizes ambient atmosphere as its source of fuel and as such is not dependent on conventional fuel systems, as satellites are.

10

### SUMMARY OF THE INVENTION

Sky Station™, as shown in Figure 1, is a large-scale (approximately 200 meters long), environmentally compatible (non-polluting either in terms of release of chemicals or energy), durable (minimum of five years), reusable, airborne, lighter-than-air platform. It uses the  
15   unique Corona Ion Engine™ to provide a stationary, high altitude (12-30 kilometers) telecommunication platform over a predetermined site. Sky Station™ is capable of broadcasting a wide range of frequencies with high bandwidths over a one-thousand kilometer area. This includes the use of laser technology at the stratospheric level for long-range, broad-band communication to other Sky Stations™ or satellites.

20

The large-scale, airborne platform utilized by this technology is only practical and economically feasible when used with the Corona Ion Engine™. Sky Station™ is stationary over a given region in order to provide easy access. Therefore, the Corona Ion Engine™ only needs to counteract the minimal wind forces at that altitude; it needs not provide propulsion  
25   and lift like aircraft engines. This ion propulsion system has significant advantages over others for this application because it has no moving parts and utilizes solar power and ambient atmosphere as its source of ions. Based on laboratory working prototypes, this

5 propulsion system without moving parts is ideal for operating at high altitudes, literally for years without maintenance.

Sky Station™ represents an opportunity to leapfrog current technology, such as fiber-optics and cellular cells on the ground and satellite network in space, to provide a broad spectrum of inexpensive, commercial telecommunication applications. This technology is expected to  
10 have significant remote sensing and monitoring applications in both civilian and defense arenas.

### BRIEF DESCRIPTION OF THE DRAWINGS

15 Figure 1 is a schematic view of a Sky Station telecommunication system of the present invention.

Figure 2 is a schematic view of a stratosphere-based global communication system, using large-scale platform structures.

20 Figure 3 is a schematic view of how laser and microwave beams establish communication between two platforms.

Figure 4 is a side view of an ion engine for use with an embodiment of the system of the  
25 present invention.

Figure 5 is a block diagram showing the structural and functional operation of an embodiment

5 of the electrical system of the present invention.

Fig. 6 is a schematic view of an embodiment of a telecommunication platform for use at altitudes up to and including the stratosphere.

## 10 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals indicate like elements through the several views.

15

FIG. 6 depicts a portion of a preferred embodiment of a global high altitude telecommunication network known as the Sky Station GSTS system. This preferred embodiment of the invention consists of a network of 250 Sky Stations 10, several thousand ground stations 85 which operate as control and switching centers, and many millions of small, inexpensive, portable and mobile Stratus Communicators 87. This preferred embodiment of the Sky Station systems operates autonomously, but also fully interconnects with the Public Switched Telephone Network (PSTN) 86. A preferred embodiment supports communications using the 47-50 GHz frequency band.

### 25 A. Geometry of a Preferred Sky Station Embodiment

In a preferred embodiment of the invention, depicted in FIG.6, the Sky Station system provides service capabilities which are intermediate between those of terrestrial and satellite

5 systems. Terrestrial wireless communications systems provide low angle of elevation coverage in urban areas and little or no coverage of the surrounding countryside. Satellite-cellular systems provide high angle of elevation coverage to both urban and rural areas, but at the expense of reduced capacity to any one area and high cost to all areas. In the preferred embodiment depicted in FIG.6, the invention provides high elevation angle service to  
10 metropolitan areas and low elevation angle service elsewhere, both at very low cost and with large capacity. The key to understanding the capabilities of this preferred embodiment of the invention begins with this embodiment's geometry.

In the preferred embodiment depicted in FIG. 6, a Sky station 10 is located approximately 30 kilometers (18 miles) above the geographic location which acts as the center of maximum  
15 population density for a coverage region. In other preferred embodiments, the Sky Station 10 may be located at other altitudes in the stratosphere or troposphere. From an altitude of 30 Kilometers, the Sky Station 10 communications payload defines coverage areas on the surface of the earth, referred to as cells 84, as is well known in the art. Directly below the Sky Station 10, the coverage area will consist of cells 84 with a one mile radius (3.14 square  
20 miles). As one moves away from the zenith, the cell sizes expand. At a distance of approximately 50 kilometers from the zenith location (approximately 31 miles along the surface of the earth), the Sky Station 10 will be at a position in the sky approximately 30 degrees above the horizon. At this radial distance, which includes approximately 3,019 square miles, the cell radius will now be approximately 4.05 miles with a corresponding  
25 coverage area of approximately 51.5 square miles. As one extends further from the zenith point to the horizon, the elevation angle for communication continues to decrease and hence the cell size continues to increase.

5 The result is that where population densities are high and transmission path obstacles are ubiquitous, such as metropolitan areas, this preferred embodiment offers both small cell sizes with resulting increased capacity and high elevation angles. Where population densities are low and building less frequent, such as rural areas, this preferred embodiment offers large cell sizes with less capacity and lower elevation angles. These fundamental geometric  
10 considerations ultimately explain the tremendous cost effectiveness of this preferred embodiment of the invention.

In other preferred embodiments, not depicted in FIG. 6, one or more Sky Stations may be positioned over any geographic region to meet local or regional communication requirements. FIG.2 depicts a preferred embodiment of a network of Sky Stations 10 providing global  
15 telecommunication capability. In this embodiment, a series of Sky Stations 10, in a geodesic domelike arrangement, encircles the earth 20 Corona Ion Engines not depicted in FIG.2, propel each individual Sky Station into position at proper stratospheric heights.

FIG.3 depicts a preferred embodiment in which Sky Stations 10 communicate with each other by high-frequency electromagnetic waves (microwaves (not depicted in FIG.3) and lasers 31  
20 extending to the UV wavelength range), thus allowing the greatest bandwidth for communication. Lasers 31 are not efficient or even possible at lower atmospheric heights because the atmosphere interferes with signal propagation by absorbing and scattering laser radiation. UV lasers cannot be used at lower heights because the ozone layer absorbs the signals. This preferred embodiment, with lasers 31, offers an alternative to the expensive,  
25 ground-based network of fiber optics, microwave or radio cellular systems.

An alternate preferred embodiment employs a Sky Station propelled by ion engines at stratospheric heights for astronomic observation requiring minimum interference from the

5 atmosphere along the line-of-sight.

A. preferred embodiment of a method for establishing a telecommunications platform for use at altitude up to and including the stratosphere includes the steps of launching one or more telecommunications platforms, maneuvering the platform or platforms into position at altitudes up to and including the stratosphere, and providing telecommunications services  
10 through the use of the platforms.

B. Technical Description of a Preferred Sky Station Embodiment In a preferred embodiment depicted in FIG. 1, a Sky Station 10 is a large-scale (650 feet long) environmentally compatible (non-polluting either in terms of release of chemicals or energy), durable, reusable, lighter-than-air platform. In this preferred embodiment, Sky Station 10 uses Corona  
15 Ion Engineers 20 to provide stationary, stratospheric telecommunications services over a wide area.

There are a large number of alternate preferred embodiments for large-scale Sky Station. FIG 1 shows a preferred embodiment of a Sky Station 10 of the present invention, which is suitable for use up to and including the stratosphere for carrying telecommunication systems, and for transponding signals from one point to another, from earth to Sky Station 10, from  
20 Sky Station 10 to satellites and from Sky Station 10 down to earth. This preferred embodiment of Sky Station 10 includes a set of ganged helium airships 12. Each helium airship may be generally conventional, made of lightweight, metal framing and fabric and inflated with helium gas. In alternate preferred embodiments, other lighter than-air gases,  
25 such as hydrogen, may be employed. Each airship 1 in the preferred embodiment shown in FIG. 1 is approximately 200 meters long and 30 meters in diameter at the maximum inflation point. These dimensions may vary considerably in alternate preferred embodiments.

5 Although two ganged helium airships 12 are shown in FIG.1, alternate preferred embodiments may employ a variety of airship types and configurations. For example, while oblong helium airships 12 are shown, spherical helium balloons or other lighter-than-air airships can also be used.

In the preferred embodiment depicted in FIG. 1, the airships 12 are joined together by a  
10 horizontal plank structure 13, which supports the solar panels 14 required for primary power. In the preferred embodiment depicted in FIG. 1, this structure 13 also supports downward-looking microwave or radio frequency antennas 15 and 16. Horizontal antennas 17 provide communications with other Sky Station 10. Upward-looking antennas 18 allow  
15 communication with satellites above and also allow astronomic observations in frequencies ranging from radio, through microwave, to laser in the infrared, optical and ultraviolet regimes. These upward-pointing antennas 18 also allow the use of Global Position Satellites (GPS) for navigation and precision positioning. The Sky Station 10. A laser port 19 allows laser light to be emitted to other Sky Stations 10 for optical communication Ion engines 20  
20 are mounted at the end of each airship and serve to navigate and to keep the Sky Station 10 stationary.

FIG.5 depicts a functional block diagram of a preferred embodiment of the electrical system of the invention. The bank of solar panels 14 provide Dc electric power for the system. The power may be temporarily stored by storage batteries 62 or fuel cells (not depicted in FIG. 5). The DC power from solar panels 14 is converted to AC power by inverter 64. Transformer  
25 66 converts AC power to the desired voltage levels for driving propeller motors 68, which may be used for tropospheric navigation. AC power is rectified by rectifier 72 to yield DC power, which provides a negative voltage for electrodes 73 in an ion engine. Computer

5 controller 76 operates the system. In a preferred embodiment, the computer controller 76  
uses software such as Labview to determine which ion engine electrodes 73 should be "fired"  
or connected to the negative high voltage, thus determining the momentum and torque  
provided by the ion engine. Computer controller 76 receives GPS navigation signals and  
uses this information to move Sky Station to a specific location or to remain stationary.  
10 Because of the desirability, in some preferred embodiments, of maintaining a Sky Station in  
the stratosphere over a long period of time, the Sky Station may be unmanned and all their  
functions controlled the computer controller 76 or remotely from the ground.

### C. Component Descriptions of a Preferred Embodiment

1. Mechanical Systems. The weight and buoyancy of a preferred embodiment of the  
15 invention, depicted in FIG. 1, is as following:

	Total buoyant gas volume	800,000 m <sup>3</sup>
	Total buoyancy	37 tons
	Envelope and Duct Weight	11.7 tons
	Fuel Cells	10.53 tons
20	Solar Cells	2.07 tons
	Power Cables & Wiring	0.50 tons
	Main Engines	1.00 tons
	Propellers & Gears	2.00 tons
	Communications Payload	2.80 tons
25	Control Equipment	0.60 tons
	Empennage	4.40 tons
	Reinforcement	1.40 tons



5

Total Weight

37.00 tons

2. Power Systems. In the preferred embodiment depicted in FIG. 1, the Sky Station 10 uses solar power, battery power and ion power. Each of these three sub-systems is discussed in more detail below.

**A. Solar Power.** In this preferred embodiment, the Sky Station horizontal plank structure, 13 includes a broad flat platform that is substantially covered with high efficiency solar panels 14. These solar panels 14, in this preferred embodiment, generate one megawatt of power, most of which is used to power the primary communication payload. Provision is made for a 50% degradation of solar panel output over time, resulting in 500 kilowatts of end of life power. Reserving 20 kilowatts of power for stationkeeping, battery charge and margin (i.e., Corona Ion Engines 20), and using a DC-RF conversion efficiency of 33 %, there will be 160 kilowatts of RF power available at end of solar panel life.

**B. Battery Power.** In this preferred embodiment, fuel cells, not depicted in FIG. 1, are used for battery power when the Sky Station 10 is in darkness. There is no issue of cloud cover because the stratosphere is above all clouds, However at night and during solar eclipses, solar electric power must be supplemented. Correspondingly, in this preferred embodiment, nearly 30% of the weight of each Sky Station 10 consists of fuel cells, and these fuel cells generate approximately 150 kilowatts of power at night. After reserving 20 kilowatts for other needs, this is approximately 80% of the daytime power generated by the solar panels 14 and is compatible with the reduced communications load expected at night. In alternate embodiments, chemical batteries or other means for storing electrical power known to the art may be used.

**C. Ion Power.** In this preferred embodiment, as depicted in FIG.1, Sky Station 10 uses ion

5 power for propulsion, relying on the plentiful flux of ions available in the stratosphere. In the troposphere conventional propellers, not depicted in FIG. 1, can drive Sky Station 10.

However, the thin atmosphere of the stratosphere renders propellers inefficient. Hence, a new propulsion system, the Corona Ion Engine 20, was invented for use at all altitudes. These engines can be used with and without conventional propellers. In this preferred embodiment  
10 the ion engine is solar-powered and uses the surrounding atmosphere as its source of gas.

The Corona Ion Engine 20, a preferred embodiment of which is depicted in FIG. 4, includes emitter electrode assemblies 47, each of which comprises a plurality of pointed electrodes.

The electrodes are biased, in this preferred embodiment, at a negative voltage in the range of -  
1 to 25 kilovolts, depending on the ambient atmospheric pressures, to create a strong electric  
15 field at the tip, which serves to eject energetic electrons into the surrounding atmosphere.

The population of charges in a gas stream can be increased by radiating a gas with focused solar (UV) radiation as shown in FIG. 3. Such radiation of short wavelength has the energy to ionize molecules into charged ions.

20 A positive electrode, not depicted in FIG.4, is positioned in the vicinity (1-5 cm distance) of the emitting electrode assemblies 47 to complete the circuit as a result there is no build-up of charges on the engine. Allowing it to sustain continuous operation. The emitted electrons are accelerated by the surrounding electric field, forming a plasma of electrons, negative ions and positive ions, by the process of ionization and charge attachment. The electrode also emits  
25 secondary electrons as a result of its bombardment by positive ions.

Negative ions, heavier than electrons by a factor of approximately 30,000, are repelled by the negatively charged emitter electrode assemblies 47 away from the ion engine 20, thereby

5        imparting momentum to the ion engine 20 in the forward direction. In a similar manner if an electrode is made positive it would then repel positive ions.

10        The positive ions, heavier than the electrons by a factor of approximately 30,000 are attracted to and hence accelerate toward the negative emitter electrode assemblies 47, imparting a momentum to the emitter electrode assemblies 47. This imparted momentum is equal to the ion mass times their acceleration velocity. The total momentum imparted to the ion engine 20 is equal to the ion density times the momentum of each ion, multiplied by the surface area of the ion engine. Note that the platform can remain charge neutral by the closed circuit mentioned above or, in an alternative embodiment, by injection an equal amount of negative and positive charges.

15        The Corona Ion Engine can be operated at a wide range of pressures, from atmospheric pressures down to the low pressures existing at ionospheric heights. Because Corona Ion Engines can produce at atmospheric pressures thrusts comparable to that of propellers driven by the same electric power, a launch strategy has been developed as follows:

20        The Sky Station will be launched from the ground via floatation using a lighter-than-air gas such as helium or hydrogen. The Corona Ion Engine and the accompanying air compressor will be used to navigate the Sky Station during the ascent of the Station from the ground up through the troposphere to the Stratosphere. Unlike an airplane which derives its lift from a minimum speed, the Sky Station can ascend at a low upward speed using the solar Corona Ion Engine for navigation function.

25        In preferred embodiments where the Sky Station is in the stratosphere, the atmospheric drag on the Sky Station is low because of the low atmospheric pressure at stratospheric altitudes.

5 The propulsion produced by the ion drive is sufficient to counter the drag force so as to move the Sky Station to its deployment location and maintain the Sky Station in a stationary position against the modest stratospheric wind. It can be demonstrated that the momentum flow due to the force off the ion propulsion can be greater than the atmospheric drag. In other words, the ion momentum is sufficient to keep the platform stationary and still against the atmosphere wind. The drag force  $F = C (1/2 \rho V^2) A$ ,

where  $\rho$  = neutral mass density,

$V$  = neutral flow velocity,

$A$  = surface area of the Sky Station

$C$  =(drag coefficient) = 0.015,

15 is balanced by the momentum flow imparted by the ion engine  $F = \rho v^2 A$

where  $\rho$  = ion mass density,

$v$ =accelerated ion velocity,

$A$ =area of the ion engine.

The accelerated ion has a much higher velocity than the neutral atom which explains why the force due to ions, in spite of the small surface area of the ion engine, can counteract the drag force of the neutral wind. Because the ion density is some fraction of the neutral density the balance between atmospheric drag and ion thrust can hold for all altitudes.

The atmosphere in the stratosphere is rarefied and is optimal for the ionization of the surrounding atmosphere by corona with the lowest electric field  $E$ . (The characteristic ratio  $E/P$ , where  $P$  is the atmospheric pressure, is near the minimum value at stratospheric pressures.) Thus, the Sky Station, operating in the stratosphere and propelled by ion engines,

5 can be maintained in a stationary position in the thin atmosphere. In a preferred embodiment, the light-weight ion engine 20, has no significant moving parts, and is ideal for high-altitude operations, using solar power as its primary source of energy.

#### **D. Corona Ion Engine.**

The Corona Ion Engine, utilizes the principles of corona ionization to produce thrust  
10 by introducing negatively charged emitter electrodes 48 into the atmosphere to eject, by means of field emission, energetic electrons. These electrons will attach to the positive side of neutral atoms causing them to become negative ions, thus forming a plasma of electrons, negative and positive ions that extend away from the corona at the tip 49 of the electrode. The negative ions are repelled by the negatively biased electrode. The reaction to this  
15 repulsion provides the forward momentum or propulsion, as illustrated in Fig. 1.

Because electrons transfer virtually all of their kinetic energy when they make ionizing collisions, it is possible to calculate the total amount of momentum developed by the engine based on the density, velocity and momentum of the ions. The equation for this calculation is  $L = N (2emV)$  where  $L$  = total momentum,  $N$  = number of atoms,  $e$  =  
20 elementary charge,  $m$  = mass of the atom and  $V$  = voltage. This equation does not take into account engine configuration, system efficiency, or other real-world variables. This equation shows that the propellant density ( $N$ ) is the most important factor in the engine's performance as it has a direct multiplying affect on the engine's thrust (momentum). Since the Corona Ion Engine uses ambient atmosphere as the propellant, it would follow that the engine intake  
25 should be configured to increase the air density at the electrode. It also follows that the thrust of the engine increases linearly with the number of electrodes.

The voltage ( $V$ ) is a secondary influence on the performance and it too is dependent

5 on the density. The denser the propellant, the more voltage is required to excite the greater number of ions. The limitation on how much voltage can be applied is when sufficient potential is reached to create an arc. Since there is no load on the electrode, there is very little if any amperage required.

10 Ion engines can be used with conventional propellers and without conventional propellers. In a preferred embodiment the ion engine is solar powered and uses the surrounding atmosphere as its source of gas. The Corona Ion Engine, a preferred embodiment of which is depicted in Fig. 4, includes emitter electrode assemblies 47, each of which comprises a plurality of pointed electrodes 48. The electrodes are biased, in this preferred embodiments, at a negative voltage in the range of -1 to -25 kilovolts, depending on  
15 the ambient atmospheric pressures, to create strong electric field at the tip 49, which serves to eject energetic electrons into the surrounding atmosphere. The emission of electrons can be enhanced by the concurrent irradiation of the electrode by focused solar ultraviolet radiation. Such focusing can be achieved with a lens.

A positive electrode, not depicted in Fig. 4, is positioned in the vicinity (1-5 cm  
20 distance) of the emitting electrode assemblies 47 to complete the circuit; as a result there is no build up of charges on the engine, allowing it to sustain continuous operation. The emitted electrons are accelerated by the surrounding electric field, forming a plasma of electrons, negative ions and positive ions, by the process of ionization and charge attachment. The electrode also emits secondary electrons as a result of its bombardment by positive ions.

25 In a preferred embodiment of the present invention, a electrode, which is comprised of a plurality of elongated members with sharpened ends which face a second electrode, is a cylinder, and the second electrode is a toroid, with the axis of the first electrode aligned with

5 the axis of the second electrode such that an atmospheric gas which is partially or highly ionized can flow past the first electrode and then past the second electrode. A means for creating a voltage difference between the first and second electrode is present such that the first electrode propels the atmospheric gas toward the second electrode. The voltage difference between the first and second electrode is sufficient to create a charge distribution  
10 on the surface of the first electrode such that, in a preferred embodiment, the atmospheric gas achieves a charge density of one million charged particles per cubic centimeter or greater. Further, this voltage difference between the first and second electrode is sufficient to emit electrons with energies sufficient to produce an avalanche of secondary electrons within the atmospheric gas in the vicinity of the first electrode. In a preferred embodiment the  
15 ionization means includes a radio frequency coil (RF).

In yet another preferred embodiment of the present invention means are provided to limit the electrical current passing through the first electrode to prevent "arcing" from occurring. In this preferred embodiment a ballast resistor is utilized to prevent this "arcing" process, as shown in the schematic of a preferred embodiment of the Corona Ion Engine  
20 circuitry.

In another preferred embodiment an RF voltage may be imposed on a coil positioned before the first electrode so as to increase the number of ions in the stream passing between the electrodes.

It is contemplated in yet another preferred embodiment of the invention that the  
25 emission of electrons from the first electrode may be increased by the direct irradiation of light or sunlight by use of a focusing lens. This process focuses sunlight on the electrode to increase electron emission.

5 As indicated in the formula outlined herein, the propellant or atmospheric density is the most important factor in the performance of the ion engine and as such it is critical that there be means by which density of the ambient atmosphere may be increased. This may be accomplished by increasing the velocity or arrival rate of the ambient atmosphere through the engine so that greater numbers of charged particles are incorporated into the stream flowing  
10 through to the electrodes. In a preferred embodiment this increased velocity or increased arrival rate is accomplished by utilizing a fan or an air compressor to accelerate the ambient particles. It is also contemplated in yet another preferred embodiment that the arrival rate of the ambient atmosphere is increased by the use of a horn-shaped cylinder or housing for the electrodes. This cylinder shape has the effect of focusing the stream of charged particles  
15 through the engine with a resulting increase in the particle stream density reaching the electrodes of the engine.

**E. Power Sources in Alternate Preferred Embodiments.** Sky Station™, in a preferred embodiment, drives its primary power from solar energy, using solar energy, using solar panels on its surface. These solar panels can be combined in series or in parallel to provide  
20 appropriate voltage to the various electrical devices on board. The energy from solar cells can be stored, in a preferred embodiment, in fuel cells which can supply energy during night-time conditions. In alternative preferred embodiments, solar power can be focused onto a surface to produce heat, raising the temperature of the surrounding gas. The discharge of this heated gas will generate propulsive force and can be used to produce electrical power as is known in  
25 the art. In other alternative preferred embodiments, solar power can also be focused onto a metallic junction formed from two dissimilar elements. The heated metallic junction then acquires an electric potential with respect to a cold junction through the phenomenon called



5 "thermoelectric effect," thus providing electrical power.

In addition to fuel cells and batteries, the Sky Station Global network can be self-sustaining in that two or more Sky Stations may provide energy for each other. As depicted in Fig. 3 the Sky Stations which are in the sunlit zone can transmit energy through a microwave link.

Since the Sky Stations operate in rarefied atmosphere, a high power communication link is  
10 feasible because of the low scattering by the atmosphere.

**F. Propulsion Source in Alternate Preferred Embodiments.** In addition to the preferred embodiment of the invention involving the Corona Ion Engine TM is the use of a vertical sail to catch the wind in such a way that a relative motion with respect to the wind result from the  
15 differential pressure between the two surfaces of the sail, similar to that on a boat. The sail normally lies horizontally until deployment. In another alternate embodiment, the use of windpower reduce the thrust required by an ion engine

Further alternate preferred embodiments employ solar power to heat gas which is to be  
20 ejected. The momentum of the exhaust gas can be increased if its temperature is increased by solar power which can be focused by suitable lenses onto a surface. The air in contact with the heated surface will then become heated, resulting in a higher thrust from the exhaust.

**3. Control Systems.** In the preferred embodiment depicted in FIG. 1, the Sky Station TM 10  
25 uses a control system, not depicted in FIG. 1, based on multiply redundant Global Positioning Systems receivers, interfaced via an on-board position-control systems to the Corona Ion Engines TM 20. This control system, in this preferred embodiment, autonomously enables

5 Sky Station TM 10 to remain fixed in position to within 100 feet in all three dimensions, and further enables each Sky Station TM 10 antenna assembly to remain accurately oriented with a maximum deviation of 0.1 degrees in any direction. In addition, a GPS information and Corona Ion Engine TM activation data, in the preferred embodiment depicted in FIG. 6, are continuously downlinked to Sky Stations 85 via embedded telemetry links 91. Thus,  
10 capability always remains for ground controllers to navigate and control each Sky Station TM via telemetry commands.

In a preferred embodiment, all but one primary and one back-up ground station will be mere "slave station" that collect telemetry data and send control information, but do not originate  
15 the control signals themselves. In this preferred embodiment, control signals will be originated only at the primary and back-up ground stations where expert engineers will be in charge. The primary and back-up control facility, in this embodiment, will use standard telecommunications links to remain in contact with the slave station control facilities. In an alternate embodiment, transportable slave ground station will be available for shipment  
20 anywhere in the world on short notice. In alternate preferred embodiments, celestial navigation, radio location, and other techniques known in the art may be used to regulate the position of the Sky Station TM 10. It should be noted that there are few position-disturbing forces in the stratosphere, which is above 99.9 percent of the oxygen atmosphere. Worst case stratospheric "winds" do not exceed 1.5 miles per hour.

25

**Communications Systems.** In the preferred embodiment depicted in FIG. 6, the communication systems of the present invention comprises the stratospheric communications

5 payload, ground station 88 and user communicators 87. All three of these systems exchange digital information in demand-assigned 64 kbps (ISDN-B) channels. In alternate preferred embodiment, these systems exchange information according to other signals types, other bandwidths or other protocols known in the art.

10           **The Stratospheric Payload.** In this preferred embodiment, the stratospheric payload, not depicted in FIG. 6, consists of a 47 GHz band beam-forming phased array antenna and a very large bank of regenerative processors that handle the functions of receiving, frequency demuxing, demodulating, decoding, data multiplexing, switching, encoding, modulating and transmitting. The stratospheric communications payload, in this preferred embodiment,  
15 reliably receives, regenerates, switches, and retransmits over one-half million transmissions simultaneously for a period of not less than ten years. Filters segment the incoming communications stream based on phased array information and frequency.

20 Separate 32dBi transmit and receive antennas are used in this preferred embodiment, each about 8 inches in diameter. A millimeter waveguide feed array projects a large number of cellular coverage areas on the surface of the earth. The precise power allocated to each cellular coverage area, and its boundary, are capable of being changed via ground control center commands. In alternate embodiments, other types of antenna systems known to the art may be used.

25 In this preferred embodiment, the Stratospheric Payload requires 160 kilowatts of end-of-life power. This power may be allocated equally to each of 2,100 cells, or may be differentially

5 allocated among cells based on channel demand, or based on the need to provide more  
transmit power to outlying cells. As an example, if each Stratus TM communicator 87  
requires 100 milliwatts of payload power, the communications payload has an overall  
capacity of approximately 1.6 million simultaneous Stratus TM communicators 87. Of course  
not all of these Stratus TM communicators 87. Of course not all of these Stratus TM  
10 communicators 87 can be accommodated in the same geographical area due to frequency  
constraints. If an embodiment of this invention is assigned initially 10 MHz of user spectrum  
for transmission to the Sky Station telecommunications facilities and 10 MHz of user  
spectrum for transmission from the Sky Station telecommunications facilities, there would be  
adequate bandwidth and power for 20 simultaneous users per cell. At 70 kHz per  
15 communicator (half duplex), this capacity calculation requires only 1.4 MHz per cell, and  
with hexagonal-pattern frequency reuse, only 10 MHz per Sky Station user link (half duplex).  
In such a preferred embodiment, maximum power utilization of this bandwidth occurs with  
76 watts per cell. In an alternate preferred embodiment, the invention may use substantially  
less power per cell but retain the ability to power additional bandwidth per cell.

20 In a preferred embodiment, there would be 100,000 subscribers per Sky Station. Assuming  
further that these 100,000 subscribers were evenly distributed across 2,100 cells, there  
would be 47 subscribers per cell, and 100,000 subscribers in a 400,000 square mile coverage  
area. This is a reasonable fit with the 20 users per cell bandwidth limited loading capacity  
25 calculated above, especially since subscribers are likely to be on-line for only part of the time.  
In a preferred embodiment, the Stratospheric Payload may incorporate a state-of-the-art  
baseband switching matrix. This technology has evolved rapidly in the past few years as a

5 result of both NASA and ESA funded programs. Complex satellite baseband processors are now well known to the art.

The overall number of discrete electronic components required for the preferred embodiment of the Stratospheric Payload depicted in FIG. 6 is large compared with that normally  
10 implemented in satellite communication systems. However, even taken as a whole, the embodiment's requirement for thousands of electronic circuits per Sky Station™ multiplied by, for example 250 Sky Stations™ in a global telecommunications system, still totals only a fraction of the electronic switched circuit requirements of the PSTN, and much less than projected electronic switched circuits for the cellular mobile telephone industry by the year  
15 2005.

b. Ground Stations. In the preferred embodiment depicted in FIG. 6, several geographically-spaced digital switches, are associated with each Sky Station™ coverage area, providing each digital switch interface to the PSTN and the Internet. The switches, located at  
20 ground station 85 or other locations will be designed to handle the maximum number of simultaneous calls. Calls will be routed to the most appropriate switch based on information determined at the Sky Station™ baseband processor in accordance with on-board programming. In a further preferred embodiment, each switch also serves as an Internet gateway site.

25 In the preferred embodiment depicted in FIG. 6, the ground stations 85 serve as base stations in the communications network. Accordingly, each ground station 85 is assigned a block of

5 bandwidth appropriate to its needed call handling capability. This bandwidth is reused in each polarization, and can be reused again at another ground station 85 a short distance away due to the narrow beamwidth that prevails at 47 Ghz. The amount of bandwidth needed for each ground station 85 is approximately equal to the number of active cells divided by the number of ground stations 85 time the bandwidth assigned to each cell 84 times the frequency  
10 reuse factor. However, this amount of bandwidth may vary considerably over time and will be reduced over time as greater numbers of calls occur among Stratus™ Communicators 87 in the same Sky Station™ Communicators 97 in the same Sky Station™ coverage area rather than through the PSTN.

15 c. Stratus™ Communicators. In the preferred embodiment depicted in FIG. 6, Stratus™ Communicators 87 are small personal communications device using solid state MMIC technology and capable of greater than 5% frequency stability. In this preferred embodiment, these Stratus™ Communicators digitize and format incoming information in accordance with the ITU-T H.263 audio-video compression algorithms, impress the same  
20 upon a 70 KHz carrier, and transmit this information using a small antenna. Each Stratus™ Communicators 87 has a unique ID code that enables it to extract communications intended for it from downlinked transmissions at the 48 Ghz frequency.

The Stratus™ Communicators 87, in this preferred embodiment, have a modular ability to be  
25 augmented with other telecommunications links such as cellular, PCS or unique nationally-authorized frequencies for indirect Sky Station™ access via relay transmitters. These Stratus™ Communicators are also be capable of direct interface to the PSTN. The recently

5 announced Oracle Internet device is a typical format for a Stratus™ Communicator.

In the preferred embodiment depicted in FIG. 6, upon triggering the "send" button a Stratus™ Communicator 87, the Sky Station™ 10 communications payload will assign an uplink channel 93 to the Stratus™ Communicator. As the incoming message is received, its header  
10 will be scanned for the telephone number of the intended recipient. If the recipient is part of the Sky Station™ network, an attempt will be made to connect directly to that recipient without the use of a ground station 85, i.e., via a simple header reformatting process and retransmission. Each Sky Station™ 10 and each switching center maintains a database listing, continuously updated, of the last location of each Sky Station™ subscriber based on  
15 his last telephone call or system inquiry. In this preferred embodiment, a software program directs a logical search for the intended recipient based on last known locations, cost and quality of the relevant PSTN, adjacent cell geometry and adjacent Sky Station™ geometry. If the incoming message indicates a recipient who is not a Sky Station™ subscriber, the call is automatically directed into an available ground station channel for interconnection to the  
20 PSTN. It is estimated that this embodiment of the Stratus™ Communicator can be built around a hybrid analog/digital VLSLASIC, with approximately 100,000 logic gates and .25 micron technology.

In another preferred embodiment, a Stratus™ Communicator 87 also includes a cellular  
25 phone capability that will be accessed whenever Sky Station™ 10 is unable to complete a communication, due for example to building blockage or any other short-term disruption in service. If such a Stratus™ Communicator 87 cannot receive transmissions from the Sky

5 Station™10, then the internal logic of Stratus™ Communicator 87 automatically looks for a free cellular phone channel. Blocked transmissions are, however, less likely with stratospheric platforms than with low earth orbit platforms because in major metropolitan areas the former are generally at much higher angles of elevation.

10 In a preferred embodiment, security features built into the Stratus Communicator 87 will emulate those of cellular and personal communications services. There will be password protection for access to the Internet web capability. Theft of service, in a preferred embodiment, can be prevented by the invention since all signals pass through a Sky Station

15 Station or at a ground switching center. In either case, upon any indication of theft of service, switches throughout the telecommunications network, in a preferred embodiment, will be able to block any calls using a suspect Stratus Communicator ID number.

Alternate preferred embodiments of the Stratus Communicators 87 may use different radio

20 frequencies, protocols and transmission types and fabrication technologies as is known in the art. Alternate preferred embodiments of these communicators may have a variety of special purpose functions, for example, a single button which sends a distress call or medical alert signal which is transmitted by the Sky Station™ to appropriate authorities. Alternate preferred embodiments of the communicators may also provide picturephone capabilities.

25

d. Antennas. In a preferred embodiments which are not depicted, Stratus™ Communicators are equipped with different optional antennas depending on their intended



5 zone of usage. Stratus™ Communicators intended for automobile or truck use may come with either a simple 3dBi external antenna for city use (much like a cellular telephone car antenna), or with an automatically steerable or electronically steerable phased array 23dBi antenna for highway/rurual use (much like a geostationary mobile satellite antenna).

10 Stratus™ Communicators, in a preferred embodiment intended for portable city use, where angles of elevation are high, will have an inconspicuous embedded antenna. However, for frequent indoor use, there may be a powered infrared remote antenna that can attach to a window and connect to the Stratus™ Communicator at infrared wavelengths.

15 Stratus™ Communicators, in a preferred embodiment intended for use in outlying areas is hundred miles from a metropolitan area, will work with a small 23dBi one-inch antenna, about the size of a business card, the 15 degree half power beamwidth of which will make for easy pointing. By simply typing in coordinates or a town name, this extended coverage Stratus™ Communicator may automatically point the build-in one inch antenna based on  
20 information stored in its memory as to the location of the nearest Sky Station™. A built-in video screen in alternate preferred embodiments of the Stratus™ Communicator may also use iconic figures to show the user which way to face for a connection to the best path Sky Station™. The user would be told if an obstacle is blocking the communications path. In this preferred embodiment, the total Stratus™ Communicator memory requirement for pointing  
25 information is less than 2 Mbytes.

For Stratus™ Communicators used at very low angels of elevation, or at horizon distances as

5 far as 350 miles from a large city, a preferred embodiment includes a five inch mini-dish antenna to maintain communications with a Sky Station.<sup>TM</sup> This 36 dBi antenna may be permanently mounted with a clear line-of-site, and would have nearly the same half power beamwidth as a DirecTV dish. In a Footprint Area Coverage zone, an example of which is shown as FAC 82 in FIG. 6, dishes included in preferred embodiments of the Stratus<sup>TM</sup>

10 Communicator may also be capable of rotating in azimuth, and modestly in elevation, in order to lock-on to the strongest Sky Station<sup>TM</sup> signal. Thus, the invention can Use site (geographic) diversity to overcome propagation challenges at 47 GHz or other frequency ranges. As is known in the art, alternate preferred embodiments of the Stratus<sup>TM</sup>

Communicator may use other types of antennas.

15  
D. Technical Description of Telecom Links used in a Preferred Embodiment.

The preferred embodiment of the invention depicted in FIG. 6 includes four different telecommunications links that occur within three different telecommunications links that occur within three different service environments: High Area Coverage (HAC) 80, Wide Area  
20 Coverage (WAC) 81, and Footprint Area Coverage (FAC) 82. This embodiment is designed to provide highly useful and low-cost telecommunications services, notwithstanding the severe challenges of radio frequency challenges in the 47 Ghz band, by relaxing the 99.9% availability constraint engineered into most wireline and fixed satellite systems to a 98% availability figure. This 98% availability figure is still much higher than most people, eve in  
25 developed countries, expect from a mobile or portable communications system, and is much higher than most people in developing countries can achieve from their wireless systems.

5 At 98% availability there is virtually nowhere in the world where the atmospheric attenuation (water vapor plus gas) at 48 GHz exceeds 1.1 dB/km of path length up to the freezing height. In other words, since more than 90% of the attenuation is due to water, propagation tables show there is virtually nowhere in the world that receives more than about 2.8 mm/hr of rainfall (1.1 dB/Km loss) for more than 2% of the year, or about 180 hours out of the 9000  
10 hour year. While 2% outage is unacceptable for television broadcasting and other communication systems, it may be entirely acceptable in some preferred embodiments of the invention as a reasonable penalty as part of a low-cost wide-band telecommunications system. Furthermore, it must be emphasized that this 2% outage figure is a worst case number -- in the vast majority of the world, 2.8 mm/hr rainfalls occur less than 1% of the  
15 time. Alternate preferred embodiments may use additional Sky Stations™, at the same or different attitudes to provide higher levels of availability.

In the preferred embodiment depicted in FIG. 6, Sky Stations™ 10 are geostationary at an altitude of approximately 30 kilometers above the earth. From this altitude, the propagation  
20 margin for atmospheric losses and coverage areas associated with the Sky Station™'s three grades of service are shown below:

It should be noted that the atmospheric loss propagation margin is substantially less than the range to a Sky Station™ 10 multiplied by the 1.1 dB/Km loss figure. The reason is that over  
25 90% of the atmospheric loss occurs due to water located in rain cells that are limited size and 98% of the time, much smaller than the range to a Sky Station™. Also, as depicted in FIG. 6, most FAC 82 users in this preferred embodiment are in the FAC 82 of more than one Sky

5 Station™ and can use site diversity to select the path with fewest rain cells.

With regard to the HAC 80 service grade in this embodiment, simple cellular phone type user terminals is able to directly access the Sky Station™, as shown in the link budget provided below. As to the WAC 81, users in this embodiment have the option of accessing the Sky  
10 Station™ directly via a modest gain antenna, or accessing it indirectly via a frequency coordinated relay transmitter. Finally, in the FAC 82 zone, users in this embodiment have the option of accessing the Sky Station™ directly via a high gain antenna, or accessing it indirectly via a nationally coordinated relay transmitter. In this and alternate embodiments, high gain antennas for FAC 82 zone reception may also be capable of rotating to access a Sky  
15 Station™ with the best propagation conditions. For example, if rain conditions are worse for one particular Sky Station™ path, the FAC ground station could shift to another Sky Station™ that has overlapping FAC coverage. It is important to note that in some preferred embodiments, as additional Sky Stations™ are deployed, users will often find themselves having WAC replace their FAC, and HAC replace their WAC.

20

1. Downlink Budge (Sky Station™ to User). The downlink budget assumes an information rate of 64 Kbps with FEC encoding and the following Modulation Parameters:

25

5

## MODULATION PARAMETERS

2/3 rate K=7	96 Kbps convolutional
Reed solomon	106 Kbps for 10% depth
OPSK:	56 Ksym/sec
Occupied Bandwidth:	67 KHz
Channel Bandwidth:	70 KHz
Eb/ No for $10^{-5}$ BER	6 dB

10

(soft decision 5 bits with coherent demodulation)

15

It will be noted that in this preferred embodiment 400 milliwatts is provided in the FAC region as compared to the 100 milliwatts in the HAC and WAC regions. AS noted earlier, each cell in the Stratospheric Payload in some preferred embodiments may have the ability to receive an allocation of greater power. This could be used to increase capacity, or to help overcome the particular moisture environment of particular cells, or to reduce antenna gain requirements.

20

The downlink budget for this preferred embodiment is as follows:

## EXEMPLARY DOWNLINK BUDGET

25

Parameter	HAC Value	WAC Value	FAC Value
Power/User	100 mW	100 mW	400 mW
	-10 dBW	-10 dBW	-4 dBW

5	Platform Gain	32 dBi	32 dBi	32 dBi
	Slant Range	58 km	164 km	600 Km
	Free Space Loss	-162 dB	-171 dB	-183 dB
	User Gain	3 dBi	23 dBi	36 dBi
	Power Received	137 dB	-126 dB	-119 dB
10	Power Noise	-153	-153	-153
	C/N	16 dB	27 dB	34 dB
	Required Eb/No for 64 Kbps			
	$10^{-5}$ BER	6 dB	6 dB	34 dB
15	Margin, down for Propagation Losses	10 dB	21 dB	28 dB

20 The downlink budget from the Sky Station™ to the ground station for this preferred embodiment is essentially the same as above except that only a small amount of power, approximately half a milliwatt, is allocated to each user since a high gain antenna may be implemented at the ground station. The resultant margin can be set as high as necessary to handle the anticipated downlink traffic load.

25

2. Uplink Budget (User to Sky Station™). In a preferred embodiment, the uplink budget is set by the need to keep user terminal power in the HAC region as low as possible to

5 minimize battery power requirements and to respect radiation hazard limits. Accordingly, the user terminal uplink power is set, in this embodiment, at 100 milliwatts (0.1 watts). Higher power is acceptable in the FAC zone because the transmitter itself is not portable but may instead be affixed to a mini-earth station outdoors or by a window. The following uplink budget results for the high angle, wide angle and footprint angle coverage regions, assuming the same  
10 modulation characteristics provided in subsection (1) above.

5

## EXEMPLARY DOWNLINK BUDGET

	Parameter	HAC Value	WAC Value	FAC Value
	Power/User	100 mW	100 mW	400 mW
10		-10.0 dBW	-10.0 dBW	-4.0 dBW
	User Ant. Gain	3.0 dBi	23 dBi	36 dBi
	Occup. Bandwidth	70 KHz	70 KHz	70 KHz
	Slant Range	58 km	164 km	600 Km
	Free Space Loss	-162 dB	-171 dB	-183 dB
15	Platform Gain	32 dBi	32 dBi	32 dBi
	$P_s$	137 dB	-126 dB	-119 dB
	$P_N$	-153 dB	-153dB	-153 dB
	C/N	16 dB	27 dB	34 dB
	Data Range	64 kbps	64 kbps	64 kbps
20	Required Eb/No	6 dB	6 dB	6 dB
	Atmospheric Propagation			
	Margin, down	10 dB	23 dB	28 dB

25        The uplink budget from the ground station to the Sky Station™ for this embodiment is essentially the same as above, except that even higher gain antennas may be used to achieve as high a margin as is necessary.



5           3.     Geographic Coverage. The geographic coverage objective for a preferred  
embodiment of the invention is all of the world's major metropolitan areas and at least 80% of  
the world's population. This coverage objective could be accomplished with 250 Sky Stations™.  
Each Sky Station™ would be positioned over one of the 250 largest metropolitan areas. In this  
embodiment, each Sky Station™ 10 provides WAC to approximately 77,000 square kilometers,  
10     representing the roughly one billion people that live in metropolitan areas, and FAC to the rural  
remainder of 80% of the world's population. Sky Stations™ could be postponed so that the  
highest density population centers HAC.

In this preferred embodiment, each Sky Station™ coverage area will consist of approximately  
15     2,100 cells, with cells becoming increasingly larger as one emanates radially outward from  
zenith. Approximately 700 cells in the HAC region have an average size of five square miles.  
The average cell size will be fifty square miles in the WAC region and 500 square miles in the  
FAC region.

20     Approximately 700 cells receive High Angle Coverage, while another 700 cells will enjoy Wide  
Angle Coverage. The remaining cells fall within the Footprint Angle Coverage contour. In this  
preferred embodiment, each cell receives a bandwidth assignment of one-seventh of the  
bandwidth allocate to the user links. The cells share the bandwidth in a hexagonal frequency  
reuse pattern to avoid adjacent cell co-frequency operation. In this embodiment, power and  
25     bandwidth are dynamically assigned to cells based on channel demand, subject to overall power  
and bandwidth reuse limitations. Ground station bandwidth is also be geographically reused  
within each Sky Station™ in a similar hexagonal pattern. Ground station bandwidth may also

5 be reused among different instances of this invention assuming adequate spatial separation of their locations.

10 It will be apparent to those skilled in the art that various modifications can be made to this invention of a telecommunications platform for use at altitudes up to and including the stratosphere without departing from the scope or spirit of the invention. It is also intended that the present invention cover modifications and variations of the telecommunications platform for use at altitudes up to and including the stratosphere, provided they come within the scope of the appended claims and their equivalents.

5

### Claims

1. A telecommunications platform for use at altitudes up to and including the stratosphere, comprising: a platform, said platform comprising telecommunication equipment capable of providing for global and regional telecommunication which is economically and environmentally compatible; said platform further comprising control means for placing said platform at a desired predetermined altitude, a propulsion source capable of holding said platform in a stationary position, a power source capable of providing sufficient energy to power said platform and said propulsion source.
2. The platform of claim 1, wherein said telecommunication equipment comprises laser technology which allows for long-range, broadband communication to other platforms or satellites.
3. The platform of claim 2, wherein said telecommunication equipment is capable of broadcasting a wide range of frequencies with high bandwidths over a predetermined area via said platform's capability to be maintained in an operational, stationary position above a given area.
4. The propulsion source of claim 1, wherein said source is capable of producing sufficient propulsive thrust to counteract atmospheric drag forces encountered at desired operational altitudes allowing for said platform to maintain a stable, stationary position.

- 5        5.        The propulsion source of claim 4, wherein said source derives its power from differential pressure resulting from temperature differences between two surfaces, one heated by solar power and the other cooled by water circulation.
- 10       6.        The propulsion source of claim 1 wherein said source utilizes a sail to derive power from the wind.
7.        The propulsion source of claim 1 wherein said source comprises an ion corona engine.
- 15       8.        The platform of claim 1 wherein said power source is derived from solar energy.
9.        The platform of claim 8 wherein said power derived from solar energy is stored by fuel cells and batteries.
- 20       10.       The platform of claim 8 wherein said power derived from solar energy is converted to electricity by photocells.
11.       The platform of claim 8 wherein said power derived from solar energy is converted to electricity by thermoelectric elements.
- 25       12.       The platform of claim 1 wherein said means to place said platform at a predetermined altitude comprises free ascent means and powered aircraft means.

5 13. The platform of claim 2 wherein said platform is capable of working in conjunction with a plurality of like platforms to form a high altitude telecommunications network for regional and global communications.

10 14. A telecommunications platform for use at altitudes up to and including the stratosphere, comprising: a platform, said platform further comprising a main body structure supported by a plurality of airships, said platform capable of ascending to a desired altitude via said airships, said body structure comprising telecommunications equipment capable of conducting local and global communications, said equipment comprising transponders and broadcast equipment capable of retransmitting information received from ground and from overhead satellites at  
15 higher power density and efficiency, said body structure further comprising means to control said platform, an ion corona propulsive source and a solar power source which derives its power from low voltage generated by solar cells using an inverter and transformer located aboard said platform, said solar power being sufficient to power said platform and said ion corona propulsion source.

20 15. The platform of claim 14 wherein said airships are helium or hydrogen airships.

16. The platform of claim 14 wherein said telecommunications equipment comprises means that include electromagnetic wave spectrum means, radio, microwave, laser and means extending  
25 to ultra violet frequencies.

17. The platform of claim 16 wherein communication between ground and platform is by

5 means encompassing the electromagnetic wave spectrum, radio, microwave, laser and extending  
to ultra violet frequencies.

18. The platform of claim 14 wherein said platform is capable of working in conjunction with  
a plurality of like platforms to form a high altitude telecommunications network for regional and  
10 global communications.

19. The network of claim 18 wherein said network platforms are capable of communicating  
with each other by utilizing electromagnetic wave spectrum means, radio, microwave, laser and  
means utilizing the ultra violet frequencies.

15 20. The platform of claim 14 wherein said propulsion source is capable of producing  
sufficient thrust to maintain the platform in a predetermined stationary position against the  
atmospheric drag in the stratosphere and troposphere.

20 21. The platform of claim 20 wherein said propulsion source comprise an electrode means,  
means for biasing the electrode to maintain it at a selected electric potential, means to create a  
high electric field in the vicinity of a sharp surface of the electrode to produce an emission of  
electrons and their subsequent acceleration, said acceleration of electrons generating positive and  
negative ions and electrons by ionization.

25 22. The platform of claim 21 wherein said generated positive and negative ions are repelled  
by an electrode attached to the platform and depending on the bias, imparting to the electrode and

5 to the platform a momentum which is sufficient to overcome the atmospheric drag in the stratosphere or troposphere so as to maintain the platform in a stationary position.

23. The platform of claim 20 wherein said electrode comprises a plurality of pointed elongated members arranged to form an emitting surface which operates in conjunction with a  
10 ring-electrode or coiled electrode of the opposite polarity which is situated to provide the return path for the electric current.

24. A telecommunications platform for use at altitudes up to and including the stratosphere, comprising: a platform, said platform comprising a main body structure supported by a plurality  
15 of airships, said platform capable of ascending to a desired altitude via said airships, said platform may also be transported to a desired altitude by motor powered aircraft as well as other lighter than aircraft such as kites and balloons, said body structure comprising telecommunication equipment capable of conducting local and global communications, said equipment comprising transponders and broadcasting equipment capable of retransmitting  
20 information received from ground and from overhead satellites at higher power density and higher efficiency due to said platform's relatively short distance from earth, said body structure further comprising a remotely controllable computer system for operation of said platform and station keeping instruments such that the location of said platform can be accurately known and controlled so as to remain stationary over a desired location, a propulsion source comprising an  
25 ion corona engine that is capable of producing sufficient thrust to maintain the platform in a predetermined fixed position against the atmospheric drag in the stratosphere and troposphere, and solar power source in conjunction with suitable power storage means capable of providing

5 sufficient power to operate said platform and said propulsion source continuously day and night.

25. The platform of claim 24 wherein said platform has a plurality of ion engines.

26. The platform of claim 25 wherein said platform may be steered by turning on selected  
10 ion engines.

27. The platform of claim 24 wherein said telecommunications equipment comprises means  
that include electromagnetic wave spectrum means, radio, microwave, laser and means extending  
to the ultra violet frequencies.

15 28. The platform of claim 24 wherein said platform is capable of working in conjunction with  
a plurality of like platforms to form a high altitude telecommunications network for regional and  
global communications.

20 29. The platform of claim 28 wherein said network platforms are capable of communicating  
with each other by utilizing electromagnetic wave spectrum means, radio, microwave, laser and  
means utilizing the ultra violet frequencies.

30. The platform of claim 24 wherein said airships are helium or hydrogen airships.

25 31. The platform of Claim 24 wherein said platform can operate up to and including the  
ionosphere due to the fact that surrounding atomspheres contain increasing numbers of charged



5 particles at increasing altitudes, said particles will be repelled by the electrode of the ion-engine resulting in forward momentum.

32. The network of claim 13 wherein said network is self-sustaining in that two or more platforms may provide energy for each other through a microwave link.

10 33. A propulsion system, comprising:

a first electrode;

a second electrode substantially in line with the first electrode wherein an atmospheric gas which is partially or highly ionized flows past the first electrode and past the second electrode; and

15 a means for creating a voltage difference between the first electrode and the second electrode such that the first electrode propels the atmospheric gas toward the second electrode.

34. The propulsion system as set forth in Claim 33 wherein the voltage difference between the first and second electrode creates a charge distribution on the surface of the first electrode  
20 such that the atmospheric gas achieves a charge density of more than approximately one million charged particles per cubic centimeter.

35. The propulsion system of Claim 34 wherein the voltage difference between the first electrode and the second electrode causes the first electrode to emit electrons with energies sufficient  
25 to produce an avalanche of secondary electrons within the atmospheric gas in the vicinity of the first electrode.

5 36. The propulsion system as set forth in Claim 35 further including means for limiting electrical current passing through the first electrode.

37. The propulsion system as set forth in Claim 35 further comprising means for superimposing an alternating voltage on the first electrode and the second electrode.

10 38. The propulsion system as set forth in Claim 33 wherein the first electrode is a cylinder with a sharpened edge, the axis of the cylinder being aligned with the second electrode and the sharpened edge facing the second electrode.

15 39. The propulsion system as set forth in Claim 33 further comprising means for focusing light on the first electrode such that the emission of electrons from the first electrode is increased.

40. The propulsion system as set forth in Claim 33 further comprising means for increasing the rate at which the atmospheric gas arrives at the first electrode.

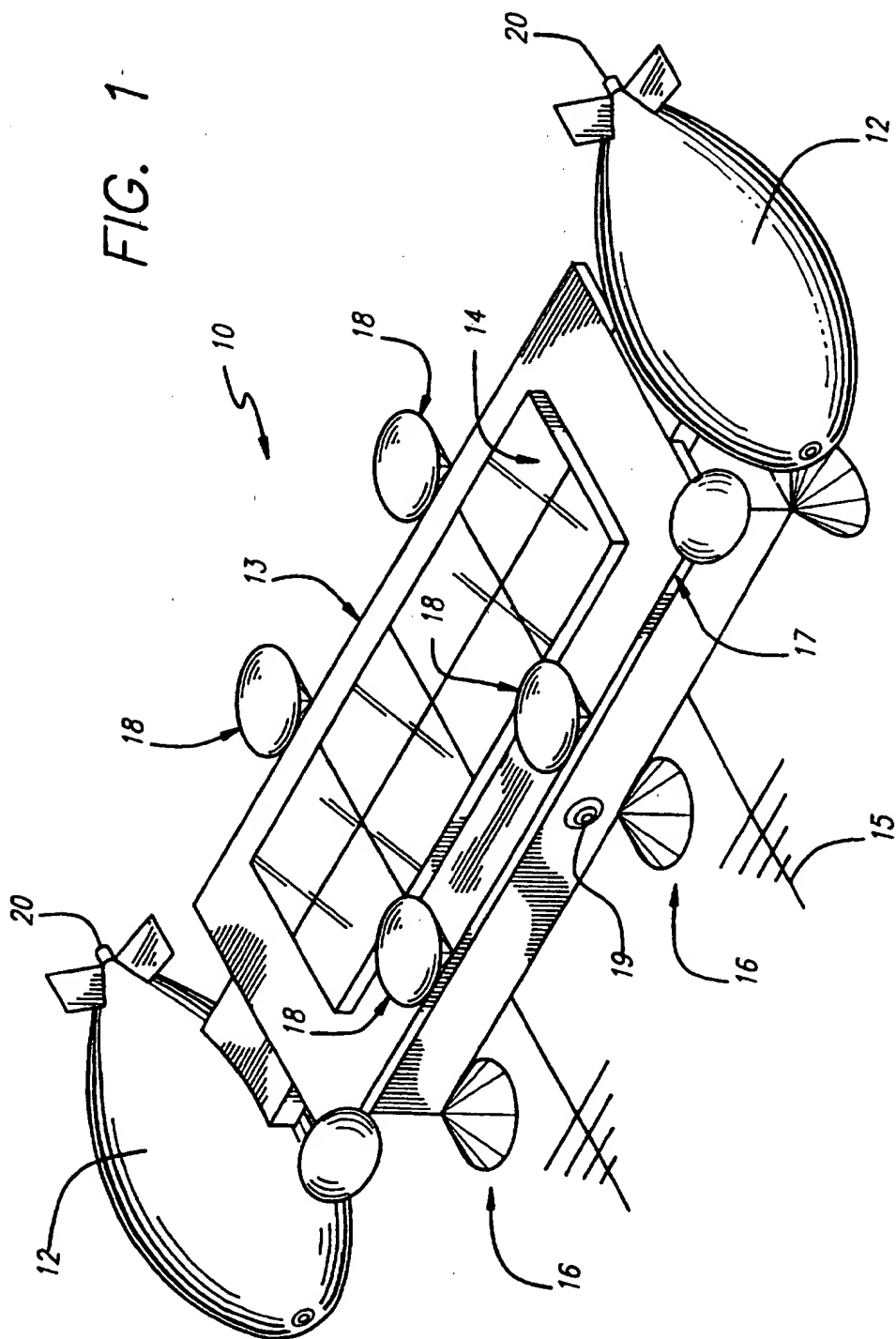
20 41. The propulsion system as set forth in Claim 40 wherein the arrival rate increasing means is a horn-shaped cylinder.

42. The propulsion system of Claim 40 wherein the arrival rate increasing means is a propeller

25 43. The propulsion system of Claim 40 wherein the arrival rate increasing means is an air compressor.

- 5 44. The propulsion system of Claim 33 wherein the first electrode is a cylinder, the second  
electrode is a toroid, and wherein the axis of the longitudinal first electrode aligns with the  
longitudinal axis of the second electrode.
- 10 45. The propulsion system of Claim 33 further comprising means for increasing the ionization  
of the atmospheric gas prior to the arrival of the atmospheric gas at the first electrode.
46. The propulsion system of Claim 45 wherein the ionization means includes a lens for focusing  
light on the atmospheric gas.
- 15 47. The propulsion system of Claim 45 wherein the ionization means includes a radio frequency  
coil.
48. The propulsion system of Claim 33 wherein the first electrode comprises a plurality of  
elongated members with sharpened ends, the elongated members being arranged in a generally  
20 cylindrical shape such that the longitudinal axis of the cylindrical shape aligns with the second  
electrode, and the sharpened ends face the second electrode.

FIG. 1



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FIG. 2

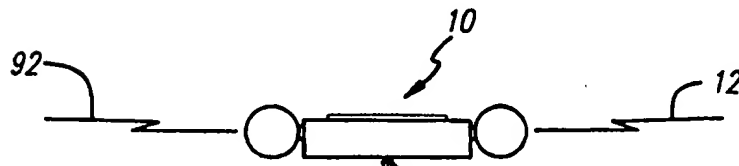
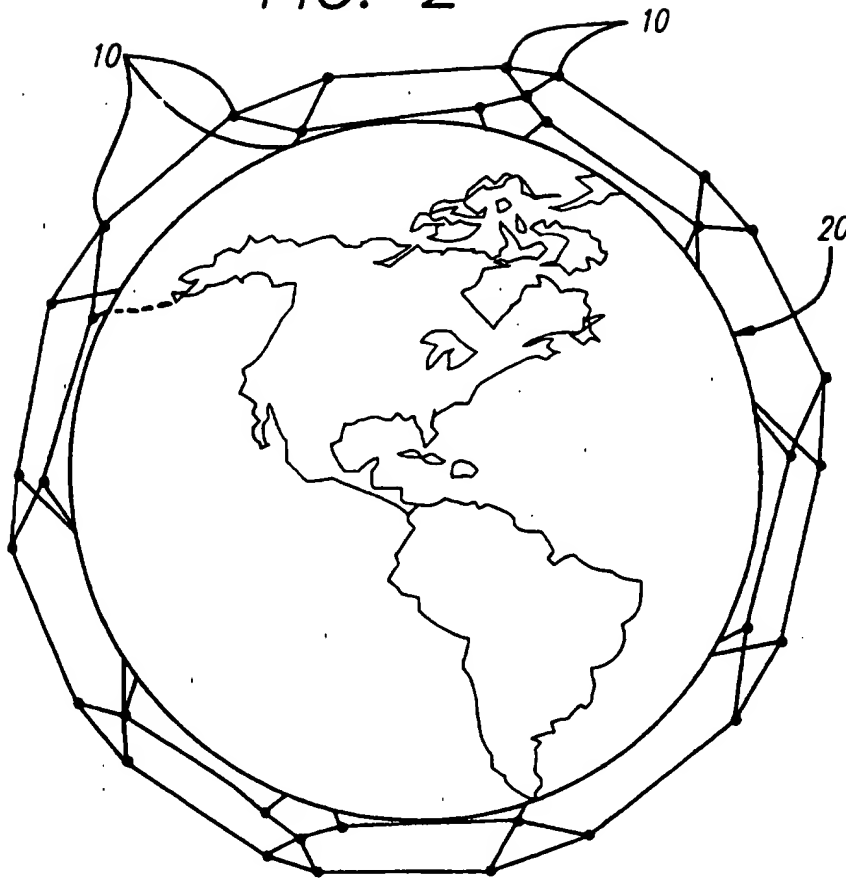
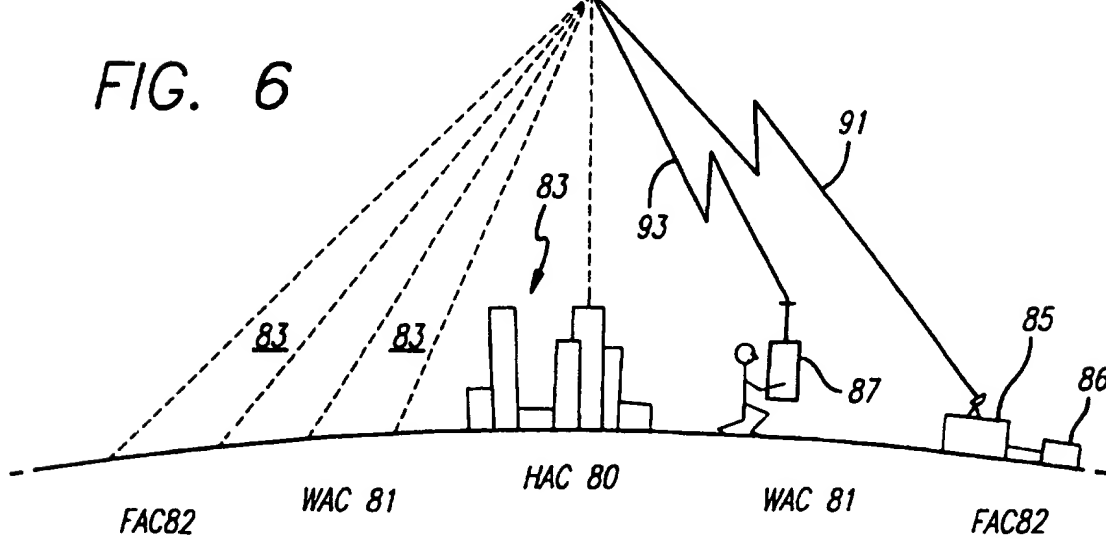


FIG. 6



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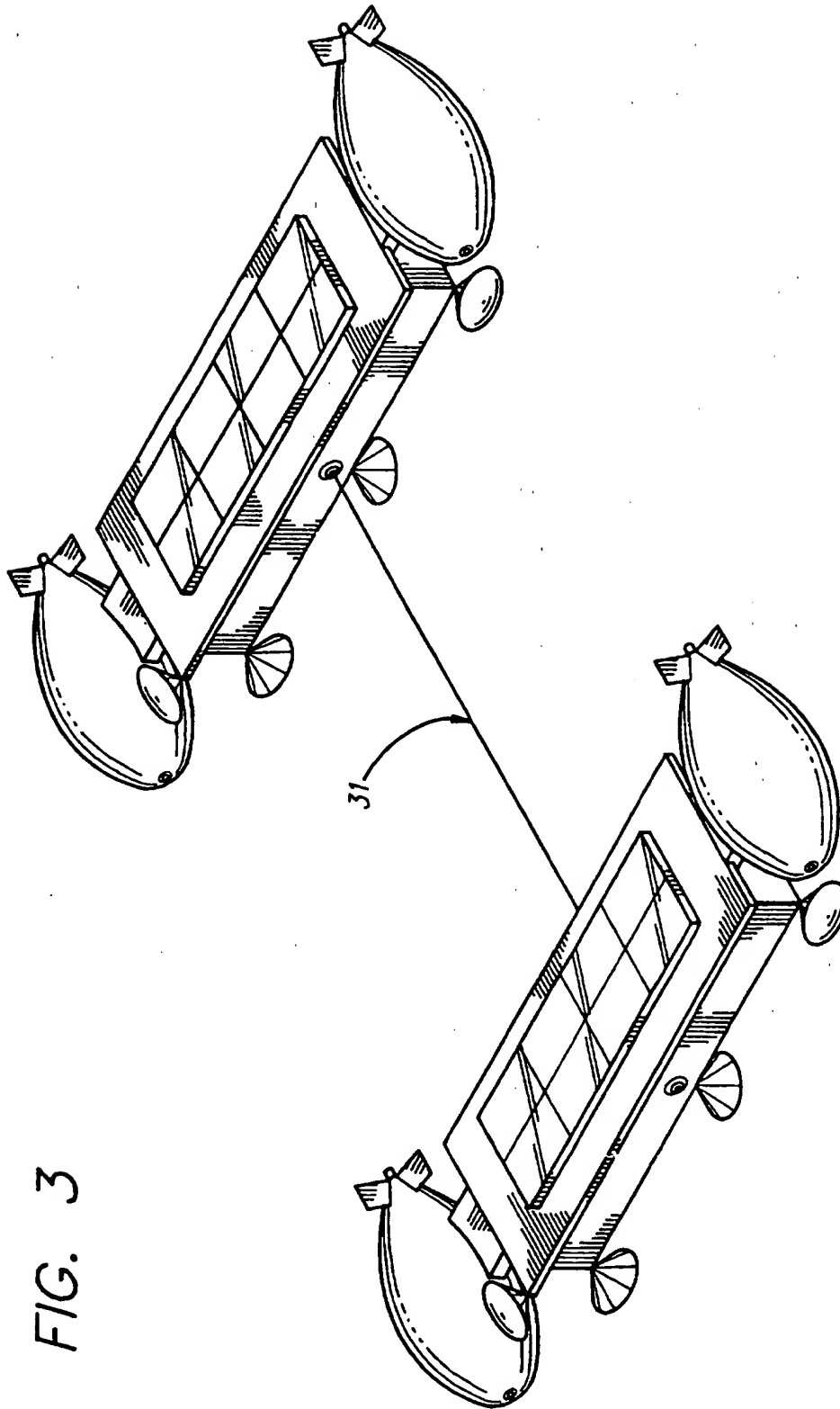


FIG. 3

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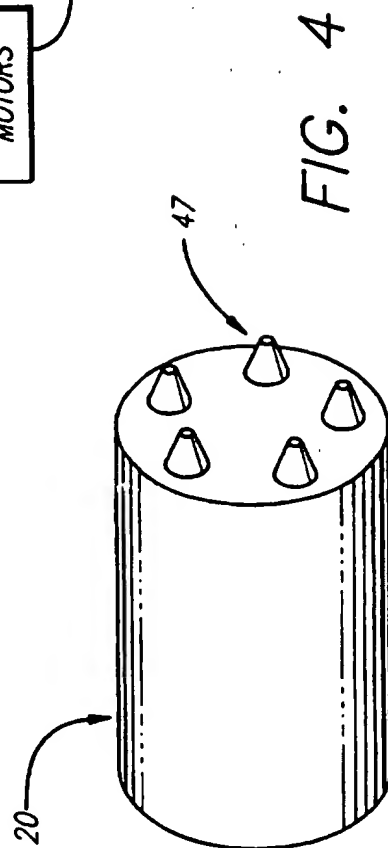
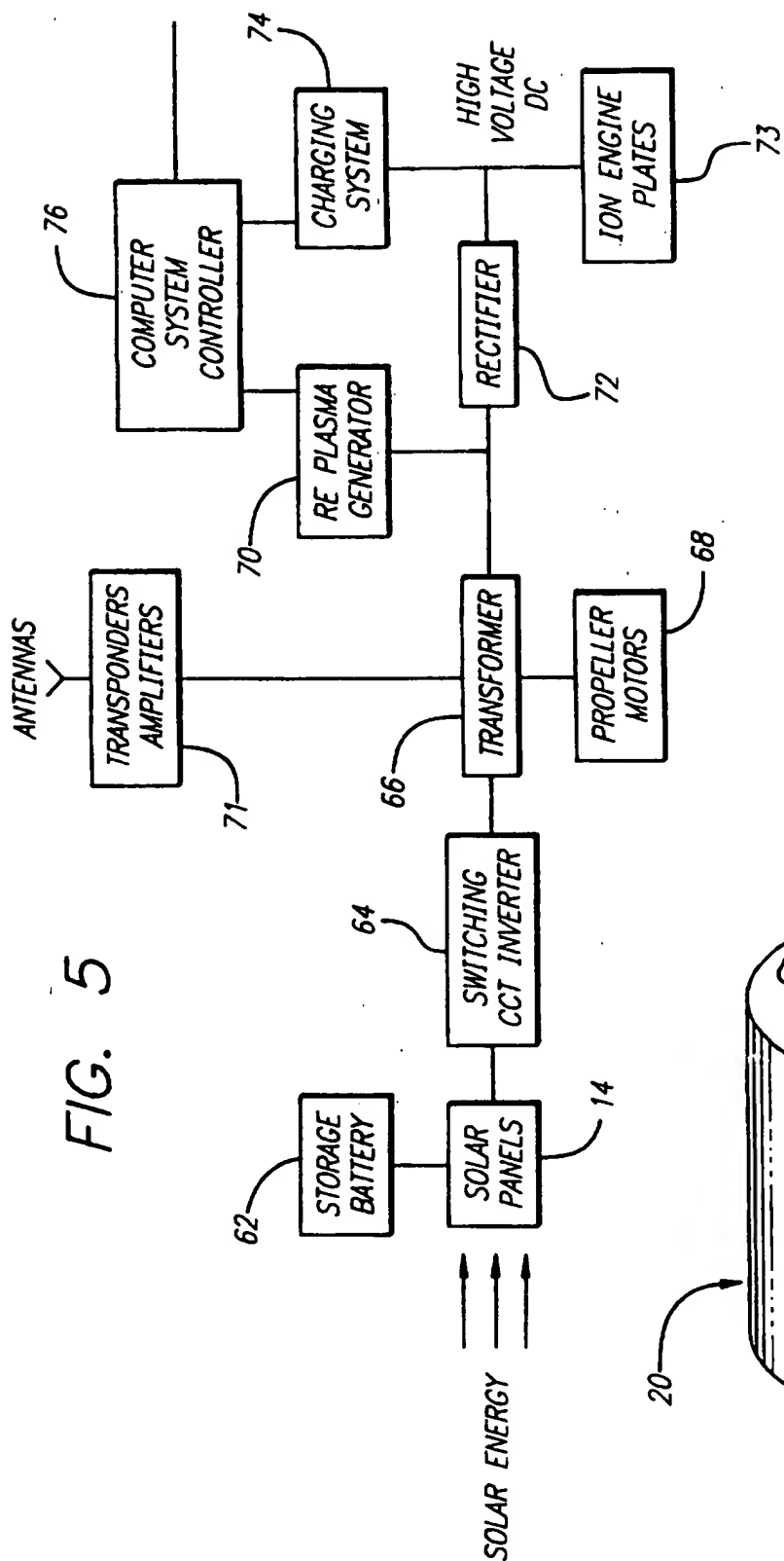


FIG. 5

FIG. 4

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US96/03568

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) : B64B 01/26; B64G 01/44, 01/24; H04B 07/185; H01J 27/00, 27/02

US CL : 244/158R, 159, 173, 30; 455/ 11.1; 60/202,208; 313/359.1, 360.1

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 244/158R, 159, 173, 30, 96, 176; 455/ 11.1; 60/201, 202, 203.1, 204, 208; 313/359.1, 360.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS search terms: communiation, telecommunication, platform, airship, stratospher, altitude, electrode, propulsion, atmospheric, gas, compressor, ion, engine, voltage,

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Please See Continuation of Second Sheet.	

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	*T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	*X*	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E* earlier document published on or after the international filing date	*Y*	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*A*	document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means		
*P* document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

30 SEPTEMBER 1996

Date of mailing of the international search report

31 OCT 1996

Name and mailing address of the ISA/US  
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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US96/03568

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 3,611,367 (BILLOTTET) 05 OCTOBER 1971, see entire document.	2, 3, 6, 8-13, & 32
X	US, A, 4,364,532 (STARK) 21 DECEMBER 1982, see Figure 4.	1,4
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Y		2, 3, 6, 8-13, 32
Y	US, A, 4,825,646 (CHALLONER ET AL.) 02 MAY 1989, see entire document.	33-37
A	US, A, 2,626,348 (NOBLES) 20 JANUARY 1953, see Figure 1.	NONE
A	US, A, 3,781,647 (GLASER) 25 DECEMBER 1973, see Figure 4.	NONE
A	US, A, 4,783,595 (SEIDL) 08 NOVEMBER 1988, see Figure 1.	NONE
A	US, A, 4,891,600 (COX) 02 JANUARY 1990, see entire document.	NONE
A	US, A, 5,465,023 (GARNER) 07 NOVEMBER 1995, col. 3, lines 23-37.	NONE

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US96/03568

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☒ No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US96/03568

## BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING

This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claim(s) 1-32, drawn to a telecommunication platform.

Group II, claim(s) 33-48, drawn to a propulsion system.

The inventions listed as Groups I and Group II do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: The Groups are drawn to two inventive concepts which are separate and distinct from each other.

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